PUNCTURE RESISTANT TEXTILE STRUCTURE, ESPECIALLY FOR SHOE SOLES

DESCRIPTION

Technical Field

This invention concerns a textile structure suitable for use in footwear, particularly safety footwear, which is required to have a high level of resistance to penetration by sharp objects such as nails and the like, especially through the sole.

Background Art

There are known systems of composite structures used for shoe soles in safety footwear designed to protect the feet from sharp or pointed objects. Some of these systems use metal plates which, however, add weight and reduce the flexibility of the shoe. The high thermal conductivity of the metal plate also makes the shoes uncomfortable to wear under conditions of high temperature. In addition, there are further problems when they are worn in places subject to the surveillance of metal detectors.

Other systems make use of layers of fabrics made of aramidic fibers bonded together by a film of thermoplastic polymers (see, for example, patent US6368989). The difficulty with protective panels of this kind is that they are very expensive, due to the use of aramidic fibers only.

Disclosure of Invention

The main object of this invention, therefore, is to provide a protective textile structure to be used in footwear, particularly shoe soles, which structure offers high resistance to piercing and penetration by sharp and pointed objects, while having limited thickness and weight, adequate flexibility and reduced cost.

A further object of this invention is to provide a perforation-resistant textile structure that is also antistatic and/or resistant to high temperatures.

These objects are achieved with a perforation-resistant textile structure in conformity with enclosed claim 1. Advantageous forms of implementation of the invention are defined in the dependent claims.

The advantages and technical characteristics of the invention will appear clear from the following detailed description of two non-limiting examples of its implementation.

Brief Description of Drawings

In the drawings:

- Fig. 1 is a schematic illustration of a first textile structure in conformity with the invention;
- Fig. 2 shows the polyester fabric used in the structure of Fig. 1;
- Fig. 3 and 4 illustrate, respectively, the profile of the warp and weft of the fabric in Fig. 2;
- Fig. 5 is a schematic illustration of a second textile structure in conformity with the invention.

Modes of Implementation of the Invention

With reference to Fig. 1 and 5, a textile structure 10,10' resistant to perforation in conformity with the invention basically consists of a number of layers 12,14,12',14' of woven fabrics bonded together by means of a thermoplastic film. In particular, the structure consists of one or more layers 12,12' of woven aramidic fibers and one or more layers of high tenacity non-aramidic fibers (for example, polyamide, polyester, polyolefin, liquid crystal fibers) woven into a fabric structure. Each separate layer of fabric has, preferably on the right side, a treated surface 16 coated with a polyurethane and/or acrylic resin reinforced with powders of hard, abrasive substances, preferably micronized ceramic materials in the form of silicates, e.g. of aluminum.

In the structure, the layers of aramidic fibers can be individually alternated with layers of fabric in non-aramidic fibers.

Two textile structures, as described more in detail hereafter, have been found to be particularly effective as well as practical to produce.

With reference to Figures 1 to 4, a first textile structure resistant to perforation consists of a multilayer structure 10 including a layer 12 of a woven fabric in aramidic fibers and, stacked on this layer 12, three layers 14 of a woven fabric in high tenacity polyester fiber. The layers are bonded together by means of a thermoplastic film. At least one side of each layer has been provided with a surface ceramic treatment 16.

Advantageously, the layers of fabric 12,14 are treated on the right side of the surface, the layer of aramidic fabric 12 and the adjacent layer 14 of polyester fabric with the treated

surface 16 being in contact, the remaining layers of polyester fabric having the treated surface in contact with the untreated surface of the adjacent layer. In this way, both outer surfaces of the multilayer structure 10 are untreated. It is also advantageous to use the structure described above inside the soles of footwear with the layer in aramidic fibers on the tread side.

Thanks to the coating of ceramic material on the individual layers of fabric, a structure produced in conformity with this invention has high mechanical resistance to perforation by pointed metal objects and impedes their progress through the layers of fabric.

In addition, this structure is advantageously characterized by the fact of being composed in a proportion that does not exceed about 15 % by weight – of the total weight of the textile fibers used - of aramidic fibers, with the remaining part in high tenacity polyester fibers. This greatly reduces the production costs with respect to structures consisting entirely of aramidic fibers, maintaining it on the order of the production costs of structures consisting of metal plates, over which it has the advantage of being highly flexible.

In the practical implementation of a protective structure in conformity with the invention, it has been found to be particularly advantageous to select fabrics 12,14 forming the multilayer structure 10 described above in the following way.

Fabric in aramidic fibers:

- plain weave;
- warp yarns in aramidic fibers, specifically Kevlar® 730 dtex, density 19 ± 2% per cm;
- weft yarns in aramidic fibers, specifically Kevlar® 730 dtex, density 15 ± 2% per cm;
- ceramic surface layer applied by coating with 90 ÷ 120 gr/sq.mt. of a compound consisting of 50% polyurethane resin, 25% acrylic resin, and 25% aluminum silicate.

The fabric produced in this way has a finished weight of 340 ÷ 350 ± 5% gr/sq.mt. with a composition by weight of approximately 80% Kevlar ®, 10% polyurethane, 5% acrylic, 5% aluminum silicate.

Fabric in polyester fibers:

- compound weave (illustrated in Figures 2 to 4), made up of two simple weaves 3X3;
- warp yarns in high tenacity (H.T.) polyester fiber 1100 dtex, density 22 ± 2% per cm;
- weft yarns in high tenacity polyester fiber 1100 dtex, density 29 ± 2% per cm;
- ceramic surface layer applied by coating with 90 ÷ 120 gr/sq.mt.

The fabric produced in this way has a finished weight of 690 ÷ 720 ± 5% gr/sq.mt. with a composition by weight of approximately 86% polyester fibers, 7% polyurethane, 3.5% acrylic, 3.5% aluminum silicate.

The weaves used make it possible to produce fabrics with very tightly woven yarns, making their structure highly cohesive to provide by their very construction a good resistance to penetration, while maintaining a high degree of flexibility.

In particular, the compound weave used for the fabric in polyester fiber has been found to be particularly effective in the production of the multilayer structure 10.

The bonding between the layers of fabric is obtained by hot calandering with the insertion of a thermoplastic film (polyolefin and/or polyurethane and/or polyester) between the layers of the structure; processing the combination with heat causes the bonding by merger of the ceramic material both with the thermoplastic film and with the surface layer of the adjacent fabric layer so as to obtain a single unit with a total thickness of not more than 3 mm and limited weight.

Advantageously, using thermoplastic film made of polyester that is resistant to high temperatures, a structure can be obtained that is particularly suitable for footwear designed to be used in the presence of high heat sources.

The textile structure described above has a general composition of:

- aramidic fibers by weight in a percentage of approximately 12%.;
- high tenacity polyester fibers by weight in a percentage of approximately 73%.;
- surface treatment in ceramic by weight in a percentage of approximately 15%.
- total weight 2435 ÷ 2555 ± 5% gr/sq.mt..

Tests carried out on the structure have proven its effective resistance to a force of at least 1100N exerted by a nail, as foreseen by standards pr EN ISO 20344, EN 344/92 and EN 12568/98.

By inserting electrically conductive wires in the fabric of the aramidic fibers and in the fabrics in non-aramidic fibers composing the multilayer structure, an antistatic structure is obtained which can be used in footwear for which this feature is required.

In particular, it is advantageous to produce the fabric in aramidic fibers with:

- the warp yarns consisting, every 74 threads, of a first yarn repeated 73 times in Kevlar® 730 dtex and a second yarn repeated once in high tenacity polyamide 180 dtex in two ply twisted with a filament in stainless steel measuring 60 micron in diameter (a composition thus consisting of 82% polyamide and 18% stainless steel);.
- the weft yarns consisting, every 56 wefts, of a first weft repeated 55 times in Kevlar® 730 dtex 730 and a second weft repeated once in polyamide and steel as described above.

The fabric in polyester fiber is in turn preferably produced with:

- 23 ± 2% warp threads per cm consisting, every 24 threads, of a first yarn repeated 23 times in polyester H.T. 1100 dtex and a second thread repeated once in polyester H.T. 1100 dtex plus a twisted filament of carbon (or steel) 24 dtex (final composition 95 % polyester 5% carbon);
- 25.5 ± 2% weft yarns per cm consisting, every 30 wefts, of a first weft repeated 28 times in polyester H.T. 1100 dtex and a second weft repeated twice in polyester H.T. and carbon as described above.

A second example of a textile structure resistant to perforation in conformity with the invention is schematically illustrated in Fig. 5.

In this case the structure 10' includes two bonded multilayers 120,140, consisting of a first set of three stacked layers of a woven fabric 12' in aramidic fibers provided with a surface ceramic treatment 16 and a second set of three stacked layers of a woven fabric 14' in high tenacity polyamide provided with a surface ceramic treatment. Advantageously, at least two adjacent layers 12' of fabric in aramidic fibers or two adjacent layers of fabric 14' in polyamide fibers or the two adjacent layers of the multilayer structures 120,140 have the treated surfaces 16 in contact with each other so that both the outer surfaces (top and bottom) of the structure 10' are not treated.

In practical implementation, it has been found to be particularly advantageous to select

the fabrics forming the multilayer structures 120,140 described above in the following way.

Fabric in aramidic fibers: as in the first example described above.

Fabric in polyamide fibers:

- weft rep weave;
- warp yarns in polyamide 6:6 high tenacity fiber, 200 dtex, taslanized and density 62 per cm;
- weft yarns in high tenacity nylon 6:6, 636 dtex, taslanized and density 16.5 per cm;
- surface layer of ceramic applied by coating of 60 gr/sq.mt. of the same compound described above.

The fabric produced in this way has a finished weight of about 300 gr/sq.mt. with a composition by weight of 80% of polyamide fibers, 10% polyurethane, 5% acrylic, 5% aluminum silicate.

A structure composed of three layers of fabric in aramidic fibers and three layers of fabric in high tenacity polyamide as described above, has a general composition of:

- aramidic fibers by weight in a percentage of approximately 38%.;
- high tenacity polyamide fibers by weight in a percentage of approximately 34%.;
- ceramic surface treatment by weight in a percentage of approximately 18%.;
- total weight approximately 2200 gr/sq.mt.

the thickness is under 3 mm (after bonding of the layers by hot calandering and insertion of thermoplastic film).

A textile structure capable of resisting penetration, as described in the above examples, is also thermally insulating and can be used, in the traditional way, as a protective insert into soles which are applied to footwear by means of sewing or gluing.

This structure can also be used advantageously in the production of footwear the sole of which is directly made on the upper by injection molding. For example, in Strobel type footwear, this structure can constitute the insole, which is first sewn onto the upper after which the sole is injected. It has been ascertained, in fact, that the effective resistance to perforation and penetration of a nail, according to the terms of standard EN 344/92, does not prevent sewing the structure onto the upper, using needles of an appropriate type.

The invention thus conceived is susceptible to numerous alterations and variations, all coming within the sphere of the inventive concept. Also, all the details can be replaced with technically equivalent elements.